Traumatic perforation of the lamina cribrosa and penetration of the brain occurred during nasotracheal intubation of a preterm infant requiring resuscitation. This rare complication is specifically associated with the nasal route of intubation. The complication resulted in significant morbidity. The infant developed an extensive intracranial hemorrhage and posthemorrhagic hydrocephalus that required ventricular drainage. We recommend that nasotracheal intubation be performed with utmost care. We confirm Cameron and Lupton’s recommendation of using a small feeding tube over which to slide the endotracheal tube. Despite extensive iatrogenic damage, the patient’s neurodevelopmental follow-up at 2 years 9 months appeared relatively mild. Pediatrics 2014;133:e762–e765

AUTHORS: Maaike J. de Vries, MD, Deborah A. Sival, MD, PhD, Elisabeth F. van Doormaal-Stremmelaar, MD, and Hendrik J. ter Horst, MD, PhD
Department of Pediatrics, Beatrix Children’s Hospital, University Medical Center Groningen, Groningen, Netherlands

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Address correspondence to H.J. ter Horst, MD, PhD, Beatrix Children’s Hospital, Department of Pediatrics, University Medical Center Groningen, PO Box 30001, 9700 RB Groningen, Netherlands. E-mail: h.j.terhorst@umcg.nl

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Endotracheal intubation is a common procedure in NICUs. It is sometimes needed to secure the airway for ventilation, to instill surfactant in preterm infants, or to remove inhaled material blocking the larynx or trachea. Common complications are cardiopulmonary compromise during the procedure; tube malposition (in 1 of the mainstem bronchi or in the esophagus); tube blockage; traumatic injury to the nares, palate, or mucosa of the oropharynx, larynx, gums, glottis, vocal cord, trachea, or esophagus; lung or airway collapse; and infection.

Endotracheal intubation is conducted either via the oral or the nasal route depending on customary practice at an institution. Both routes have advantages and disadvantages, but to date insufficient evidence is available to determine which is the better option. It is often claimed that oral intubation is easier to perform and less traumatic to the infant, but this claim is not supported by high-quality clinical evidence. Other authors claim that nasal tubes are easier to secure and accidental extubation occurs less often.

At our level III NICU, nasotracheal intubation is the preferred route of intubation. Of the 600 infants admitted annually, 45% require endotracheal intubation. Clinicians must be prepared to recognize and manage complications. Intracranial deviation of nasogastric tubes has been reported repeatedly in the literature, whereas, to our knowledge, intracranial deviation of a nasotracheal tube has only been reported twice, once in an adult and once in an infant. Intracranial deviation has been described more often in association with facial and basal skull fractures. To date, information on neurodevelopmental outcome is lacking. In the present case report on a preterm infant, we describe a rare complication after nasotracheal intubation. It involved iatrogenic perforation of the lamina cribrosa with extensive cerebral trauma resulting in extensive morbidity. Nevertheless, we diagnosed only mild neurodevelopmental delay in the patient at 2 years 9 months.

CASE REPORT

A boy was born at a gestational age of 28 weeks 4 days by breech extraction. He weighed 1260 g. Results of prenatal ultrasound and chorionic villus biopsy (required because of maternal age) were normal. In the absence of spontaneous respiration, positive pressure ventilation was initiated and continued because of inadequate respiratory effort and a heart rate of <60 beats per minute. Apgar scores were 1 at 1 minute and 1 at 5 minutes. The infant did not respond to bag and mask ventilation, and he was thus intubated by an experienced, fourth-year pediatric resident. A lubricated endotracheal tube (Rüsch 3.0, Teleflex, Athlone, Ireland) was readily introduced into the left nostril without encountering any resistance but, after introducing the laryngoscope, the endotracheal tube was not visible in the oropharynx. The tube was removed, and the infant was again ventilated with bag and mask. A second attempt at intubation via the left nostril was conducted by an experienced neonatologist. Once again the tube was invisible, and bloody serous fluid in the oropharynx indicated iatrogenic perforation of the lamina cribrosa. Ventilation with bag and mask was restarted, and because the infant’s heart rate dropped to <60 beats per minute, chest compressions were given. Oral intubation was unsuccessful due to the large amounts of serous fluid that made it impossible to visualize the upper airway. Six minutes later, an endotracheal tube size 2.5 was readily introduced into the trachea via the right nostril, after which ventilation was adequate. During this successful intubation, it was possible to suction the large amounts of fluid, while the nasopharyngeal tube had already been introduced into the hypopharynx. Subsequently, the tube could be introduced into the trachea before vision was blocked once again. Because bradycardia persisted, chest compressions were continued, and we administered epinephrine (0.01 mg/kg) 3 times and a volume expansion was given (saline 0.9% 10 mL/kg). At 14 minutes, the infant’s heart rate had increased to >100 beats per minute, and he became vigorous and pink. He was then ventilated and transferred to the NICU with no further problems. After his condition had stabilized, a physical examination of the infant revealed an imperforate anus. We found no other congenital anomalies.

We performed a cranial ultrasound shortly after the infant’s admission to the NICU. It revealed a linear density from the region of the left lamina cribrosa to the left occipital lobe, consistent with the intracranial deviation of the nasotracheal tube (Fig 1). Brain MRI on the second day after birth showed a left frontal parenchymal hemorrhage at the left basal ganglia and caudal thalamic region with dilation of the ventricles (Fig 2). Serial ultrasound scans demonstrated the evolution of a large left porencephalic cyst and posthemorrhagic ventricular dilation (Fig 3). When the infant was 7 weeks old, we performed an endoscopic third ventriculostomy (a surgical procedure whereby the floor of the third ventricle is fenestrated), followed by a ventriculoperitoneal shunt at 11 weeks due to progressive hydrocephalus. Two weeks later, we performed a β2-transferrin test of the nasal fluid; the results were negative for liquor leakage. A computed tomography scan at the age of 2 years revealed that the child’s skull base was intact.

Initially, we treated the imperforate anus with a sigmoidostomy. When the...
patient was 5 months old, we performed an anterior sagittal anorectoplasty. When the boy was 8 months old, we reversed the colostomy, and he required daily dilation until the age of 2 years 6 months. At this age, the boy was admitted to the PICU of our hospital with respiratory insufficiency and status epilepticus due to sepsis meningitis caused by Streptococcus pneumoniae. The status epilepticus was successfully treated with midazolam, clonazepam, and phenytoin, and the ventriculoperitoneal shunt was revised. He recovered and was discharged after 2 weeks of antibiotics.

At the age of 2 years 9 months, the boy’s head circumference was 50.5 cm (0 SD). Motor assessment revealed unilateral cerebral palsy with a level I score on the Gross Motor Function Classification System. We detected no blindness, hearing loss, or epilepsy. On the Bayley Scales of Infant and Toddler Development, Third Edition, he had a mental development index score of 90 and a psychomotor development index score of 102 (normal score 100, SD 15). The child behavior checklist, completed by the parents, revealed no behavioral problems.

DISCUSSION
We present a case in which nasotracheal intubation accidentally perforated the lamina cribrosa of a preterm infant, which caused a large intracerebral hemorrhage followed by posthemorrhagic hydrocephalus. Despite the fact that nasotracheal intubation is performed frequently at our NICU (∼250 intubations annually), this serious complication had never occurred before. We cannot explain why it occurred, although it is tempting to speculate that possibly the thin and incompletely fused facial bones of the preterm infant were related to the incident. Although traumatic penetration of the brain during nasal intubation has only been reported twice,8,9 less...
damaging injuries to the cribiform plate and posterior nasal bones may have gone unnoticed. In the wake of such a serious complication, it is tempting to recommend that preterm infants always be intubated orally. We are unaware of any evidence, however, that supports the superiority of orotracheal intubation over nasotracheal intubation. Generally speaking, the reasons for choosing a particular route of intubation are subjective. If it is an institutional policy to intubate preterm infants via the nasotracheal route, we recommend inserting the endotracheal tube in the nostril and up the nasal cavity with utmost care. Rotating the tube should be avoided at all cost. Whenever any resistance is encountered, the nasal tube should be removed immediately, and we recommend switching to orotracheal intubation. As recommended by Cameron and Lupton, it may be helpful to insert a nasogastric tube inside the endotracheal tube to act as a guide wire along which the endotracheal tube is gently moved. Nevertheless, we point out that this procedure might also result in inadvertent intracranial perforation.

Clinicians involved in intubating neonates should be aware of the potential hazards associated with nasotracheal intubation in preterm infants. Everyone who uses this procedure should be keenly aware of the fragility of the posterior nasal structures. If the nasotracheal tube is not visible in the pharynx, then its uncomplicated passage through the nose probably failed, and bloody serous fluid dripping from the nose signifies this alarming and rare complication.

The complication described here resulted in significant morbidity. This case showed that despite extensive iatrogenic cerebral damage, it was difficult to predict neurodevelopmental outcome shortly afterward. In >50% of preterm children with very low birth weights (<1500 g), cognitive, behavioral, and mild motor problems occur even in the absence of overt brain injury. Given the extensive morbidity, including hemorrhagic brain lesions, drain complications, preterm birth, perinatal asphyxia, status epilepticus, and meningitis, we had expected more severe handicaps at follow-up. Nevertheless, at the age of 2 years 9 months, the boy’s scores were within the normal range on the mental and psychomotor development indices of the Bayley Scales of Infant and Toddler Development, Third Edition. He did, however, have a mild contralateral spastic hemiplegia (Gross Motor Function Classification System level I, which meant he could move from sitting to standing without adult assistance and that he could walk without any assistive mobility device). In addition, the parents reported no behavioral problems. We are aware of the fact that the follow-up period was relatively short, especially because cognitive and behavioral deficits may only become apparent later on as school becomes more demanding.

CONCLUSIONS

Endotracheal intubation via the nasal route could be complicated by perforation of the lamina cribrosa. Despite serious iatrogenic morbidity, the patient’s neurodevelopmental delay at the age of 2 years 9 months was relatively mild.

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REFERENCES

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